sheets of metals. It is, however, shown by J. Precht and C. Otsuki, in the *Verhandlungen* of the German Physical Society (vol. vii. p. 53), that hydrogen peroxide itself is capable of penetrating thin films of gelatin, celluloid, india-rubber and black paper, the peroxide being subsequently capable of detection by titanic acid. Metals in the form of the thinnest sheet are, nevertheless, impervious to hydrogen peroxide, if small holes be not present; the same is true of thin films of paraffin, glass, and ebonite.

Two papers dealing with the accurate measurement of coefficients of expansion are contained in the January number of the *Physical Review*. Mr. H. McAllister Randall describes the determination of the coefficient of expansion of quartz between the temperatures of 36° and 500° C. by means of Pulfrich's optical method, and shows that up to about 250° C. the expansion of quartz follows a straight-line law; between 250° and 470° C. it is necessary to include a term involving the square of the temperature, whilst at 500° C. a sudden large increase in the expansibility becomes visible. At this temperature it is probable, as suggested by Le Chatelier, that quartz undergoes a change into a second modification having very different physical properties from those of the ordinary form. The second paper, by Mr. H. D. Ayres, deals with the measurement by Pulfrich's method of the coefficients of linear expansion of the metals aluminium and silver at temperatures between 100° and −184° C.

THE firm of Leybolt Nachfolger in Cologne has recently issued a very complete and interesting catalogue of physical apparatus and fittings sold by them. The book starts with a history of the instrument trade in Cologne during the last century. In its second section we find an account of the construction and fittings of various chemical and physical institutions. It is noteworthy, perhaps, that while the students' laboratory, with its work tables and appliances for experiments, figures prominently in the chemical institutions, the arrangements for practical work by the students in the physical laboratories are distinctly less complete. After this follows the catalogue proper, filling some 800 large pages, profusely illustrated and admirably arranged. The book will be most useful to the teacher, and is a striking illustration of German enterprise and go. At the same time it is observable throughout that the apparatus is intended chiefly for demonstrations and the lecture-room. The list of electrical measuring instruments, for example, is comparatively meagre, while there are not many examples of the simpler forms of apparatus supplied to an English school laboratory for use by the students. It is probably the case that such apparatus is less used in Germany than here, but though this is absent the book is full of apparatus of the greatest value and utility.

A SECOND edition of Prof. Luigi de Marchi's "Meteorologia generale" has been published by the house of Hoepli, of Milan. The book has been revised and enlarged.

A SECOND edition of the "Rural Calendar," fully revised and enlarged, has been prepared by Dr. A. J. Ewart and published by Messrs. Davis and Moughton, Ltd., Birmingham. The book is a helpful index to observations of animate nature throughout the year, and a guide to gardening and farming operations. It includes an artificial key to the commoner wild British herbs, giving description, common name, scientific name, and natural order. By using this key as plants become available, a good knowledge of common flowers may be obtained. The price of the book is one shilling net.

OUR ASTRONOMICAL COLUMN.

STRUCTURE OF THE CORONA.—In an interesting paper published in No. 3 (1905) of the *Revue générale des Sciences*, Dr. Ch. Nordmann discusses the structural details of the solar corona and their causes. In the first place, he shows that the incurvation of the coronal rays cannot be due solely to the action of gravitation, for the angles which they make with the normals to the limb at the points of their projection are far too small for this theory

He then shows that the "minimum" corona, which obtains at the time when the solar surface is least disturbed simply assumes the form natural for it to assume under the action of centrifugal force, if it be granted that the particles forming the coronal streams are exactly balanced in the solar atmosphere—that is to say, if their weight is counterbalanced by the force of the light-repulsion. At times of "maximum," when the solar surface in the sun-spot (*i.e.* equatorial) region is most disturbed, the local disturbances, and their consequent convection currents, modify the action of the normal centrifugal forces, and thus produce the *abnormal* coronas observed at eclipses occurring during periods of maximum solar activity, which, although of the same general form, vary greatly in their detailed features.

RADIANT POINT OF THE BIELID METEORS.—From a number of observations of the Bielids made on November 21, 1904, Herr K. Bohlin, of Stockholm, has calculated the radiant point of the shower.

The resulting position is only about 3° from γ Andromedæ, and has the following coordinates:—

1904 November 21·33 (Mid-European time).

$$\left.\begin{array}{l}\alpha = \ \ 26^\circ \ \ 2' \\ \delta = +43^\circ \ 10'\end{array}\right\} 1900.$$

(*Astronomische Nachrichten*, No. 3997.)

BRIGHTNESS OF ENCKE'S COMET.—The results of a number of magnitude observations of Encke's comet, made by Herr J. Holetschek, at Vienna, during the present apparition, are published in No. 3997 of the *Astronomische Nachrichten*. The observations covered the period November 25–December 27, and, in the table wherein the results are shown, the vertical diameter, the magnitudes of the nucleus, and the magnitudes of the whole comet are given. From the last-named values we learn that on November 25 the magnitude of the comet was 9·0, on December 10, 6, and on December 23, 5·3. The value obtained on December 27 was mag. = 5·0, but this is queried.

JANUARY FIREBALLS.—A note from Mr. Denning to the *Observatory* (No. 355) shows that the appearance of fireballs during the predicted dates in January was well sustained. On January 14 a bright object was seen by several observers, and on combining the records a radiant point situated in Monoceros at 119° + 3° was obtained. The height of this fireball ranged from 60 miles over Brecon to 29 miles over Aberystwith. Two fireballs were seen on January 27 and one on January 29, thus corroborating the January 28 epoch. One of those on the former date was very bright, and was apparently stationary at 118° − 18°.

In February, bright fireballs were seen on February 11, 13 and 18, the time of the apparition on the last-named date being 7h. 15m. a.m., *i.e.* in daylight.

ROTATION OF JUPITER'S SATELLITES I. AND II.—During the period January 13–20, Dr. P. Guthnick, of Bothkamp Observatory, made a series of magnitude observations of Jupiter's first and second satellites, the period of observation covering about four revolutions of the former and two revolutions of the latter round the planet.

The measurements were made with a Zollner photometer attached to the 11-inch refractor. Plotting the values obtained on curves having the "anomaly" of each satellite as abscissa and the corresponding apparent magnitude as ordinate, it was seen that the period of the light-variations coincided with that of the revolution about Jupiter, and as a consequence it seems probable that the periods of revolution and rotation are coincident in each case (*Astronomische Nachrichten*, No. 4000).

ORBITS OF MINOR PLANETS.—In No. 4000 of the *Astronomische Nachrichten*, Prof. J. Bauschinger publishes the

elements of the orbits of those minor planets discovered during 1904 of which the paths have been computed at the Berlin Astronomischen Recheninstitut. The list contains the orbits of 28 minor planets, 24 (523–549) of which are referred to the epoch 1904.0, and 4 (550–553) to 1905.0, and is followed by a series of remarks which name the observations on which the computations were based, and the corrections to some of the orbits as obtained from subsequent observations. A note concerning (526) NQ says that that object is probably identical with 1901 HA.

An additional list of five asteroids discovered during November and December, 1904, and to which the permanent numbers 549–553 are now allotted, brings the total number discovered during last year up to thirty-two.

EFFECT OF AUTUMNAL RAINFALL UPON WHEAT CROPS.[1]

By autumn, in this note, is to be understood the period from the thirty-sixth to the forty-eighth week, both inclusive, of the year, as represented in the *Weekly Weather Report* of the Meteorological Office; it covers the months of September, October, and November, approximately. The rainfall to be referred to is the average amount in inches, for the "Principal Wheat Producing Districts," for the period mentioned, in successive years. The amounts are taken from the summaries of the *Weekly Weather Report.*

The yield of wheat is that given for successive years in the annual summaries of the Board of Agriculture and Fisheries as the average yield in bushels per acre for England, since 1884, or more strictly since 1885, as that is the first year for which the figures for England are given separately. In 1884 the figure for Great Britain, which generally differs but little from that for England, is used.

These are the only figures in the official publications which are immediately available for the purposes of comparison. The totals of rainfall for the thirteen weeks have been compiled from the weekly amounts, otherwise the figures are taken as they stand in published returns. The areas referred to are not exactly coterminous, but they are more nearly so than if the rainfall values had been taken for the whole of England, or the wheat yield for Great Britain.

When the autumn rainfall and the yields of wheat for successive years from 1884 to 1904, as thus defined, are plotted, the rainfall curve being inverted, *i.e.* rainfall being measured downward on the paper while yield is measured upward, there is a very striking similarity between the curves, so much so as to suggest that if the scales were suitably chosen the two curves would superpose and show general consonance, with exceptions, more or less striking, in a few of the years. In other words, the yield of wheat in any year seems to depend mainly on the absence of rainfall in the previous autumn, and but little on any other factor.

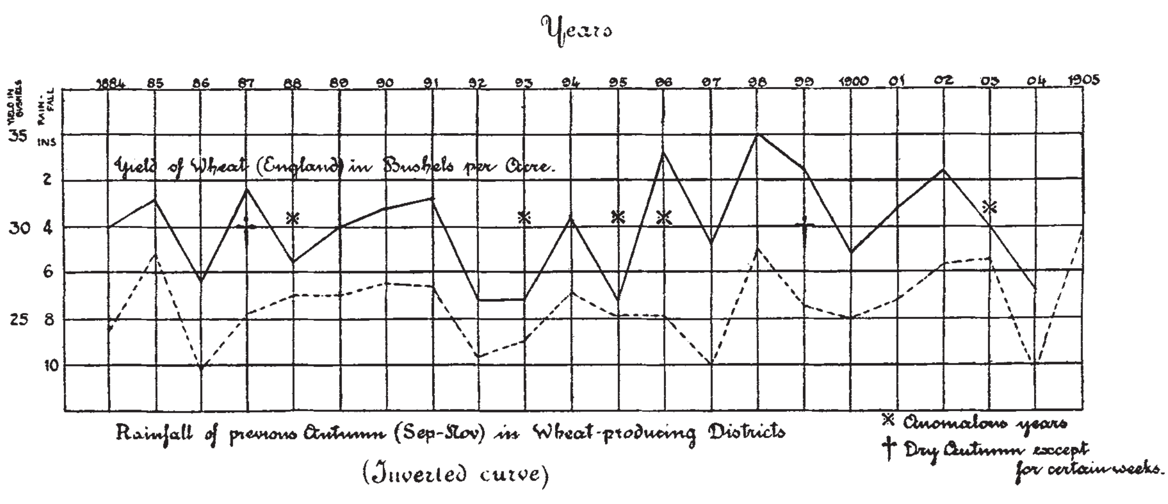
The obvious algebraical expression for such a condition as the curves represent is a linear equation, and the equation which represents the relation between yield of wheat for England and the previous autumn rainfall is :—

Yield = 39.5 bushels per acre − 5/4 (previous autumn rainfall in inches).

If we call the yield obtained from the rainfall by this equation the "computed yield," a comparison with the actual yield for the twenty-one years shows that the computed yield agrees with the actual yield within half a bushel in seven years out of the twenty-one. In fourteen years the agreement is within 2 bushels; in the remaining seven years the difference between computed and actual yield exceeds 2 bushels. The extreme variation of yield in the twenty-one years is 9 bushels, from 26 bushels per acre in 1892 and two other years to 35 bushels per acre in 1898.

Of the seven years for which the formula gives yields differing from the actual by upwards of 2 bushels, 1896 is the most conspicuous; its actual yield exceeds the computed yield by 4.5 bushels.

These seven years all show anomalous seasons. Taken *seriatim,* they are 1887, 1888, 1893, 1895, 1896, 1899, and 1903.



In 1888 and 1903 the crops were washed away by 10 inches of rain in the summer; 1893 is the year of phenomenal drought, and the crop was below the computed figure by 2.5 bushels. The years 1892 and 1899 are interesting, because though the amounts of rain were up to the average, the former had eight dry weeks and the latter ten dry weeks out of the thirteen included in the conventional autumn. They were thus dry autumns, the average amount of rainfall being made up by a few exceptionally wet weeks. The yields correspond with dry autumn values. They are above the average and above the computed figures by some 2 or 3 bushels per acre.

There remain 1895 and 1896. 1895 was the year of remarkably cold weather, and in that year the yield fell short, but in the following year the deficiency was made up by a yield as much above the computed value as the previous one fell short. It would appear that in this instance the productive power not utilised in the year of the great cold was not lost, but stored. On the other hand, it must be remarked that 1896 had the advantage of a specially dry winter.

It appears from these considerations that the dryness of autumn is the dominant element in the determination of the yield of wheat of the following year. The averages of yield and of rainfall are taken over very large areas, and it may be taken for granted that the investigation of the question for more restricted areas would introduce some

[1] "On a Relation between Autumnal Rainfall and the Yield of Wheat of the following Year.—Preliminary Note." By Dr. W. N. Shaw, F.R.S., Secretary of the Meteorological Council. Read before the Royal Society on February 2.